APPLICATION UNDER UNITED STATES PATENT LAWS

Invention: **HOME ADAPTIVE TRANSCEIVER FOR HOME NETWORKING COMMUNICATION SYSTEM**

Inventor(s): Gang HUANG;
Zhenyu WANG; and
Jingou YU

Manelli Denison & Selter PLLC
2000 M Street, NW
7th Floor
Washington, DC 20036-3307
Attorneys
Telephone: (202) 261-1000

This is a:

[ ] Provisional Application

[X] Regular Utility Application

[ ] Continuing Application

[ ] PCT National Phase Application

[ ] Design Application

[ ] Reissue Application

[ ] Plant Application

SPECIFICATION

HOME ADAPTIVE TRANSCEIVER FOR HOME NETWORKING COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to networking computers within a small environment such as a home. More particularly, it relates to a home networking communication system using an adaptive transceiver.

2. Background of Related Art

Home networking systems provide local area network (LAN) solutions for home and/or small business using a telephone line.

Fig. **4** illustrates a conventional star network.

In particular, Fig. **4** illustrates a topology conventionally known as a star network. A star network is one in which network devices or network nodes **310**, **320**, **330**, **340** and **350** are connected to a central computer **360** in a star-shaped configuration.

Messages in a star network pass from any of the network nodes **310**, **320**, **330**, **340** and **350**, to the central computer **360**. The central computer **360** examines a destination address attached to each message, and directs the message to the appropriate network node **310**, **320**, **330**, **340** or **350**. The central computer **360** also acts as a network node and directs its own messages to any of the satellite nodes **310**, **320**, **330**, **340** and **350**.

Fig. **5** illustrates a conventional ring network.

In particular, Fig. **5** illustrates a topology conventionally known as a ring network. A ring network is one in which network devices or network nodes **410**, **420**, **430** and **440** are connected in a closed loop, or ring by paths **415**, **425**, **435**, and **445**.

Messages in a ring network pass around the ring from network node to network node in one directtion, e.g., from network node **410** to network node **420** over path **415**, from network node **420** to network node **430** over path **425**, from network node **430** to network node **440** over path **435**, and back to the first network node **410** over path **445**. When a network node **410** receives a message, it examines the destination address attached to the message. If the address is the same as that node's, the node **410** will accept the message. Otherwise, that network node **410** will regenerate the network message and pass it along to the next network node **420** in the given direction along the ring.

Star networks are subject an entire network failure if the central computer malfunctions. Satellite node malfunctions are less severe in this type of network, as any particular node will not typically have a negative affect on the remaining devices in the star network. Adding network nodes to a star network is simplified because it requires a new path only between the new network node and the central computer.

The performance of home networking transceivers mainly depends on the channel properties and noise environment, both of which vary from home to home. Channel properties are determined by the topology of the telephone line wiring, the condition of the telephone line and/or the types and number of devices connected to the telephone line. For instance, different devices connected on a particular telephone line will cause different echoes, different losses and/or different distortions to signals thereon.

Different homes have different wiring systems for phone lines, making the topology of a phone line network and line conditions completely different from home to home. These variations make it almost impossible to design a unique transceiver that is a best fit to all homes or small businesses.

SUMMARY OF THE INVENTION

In accordance with the principles of the present invention, a self calibrating network comprises a first node and a second node. The first node transmits a calibration data packet. The second node receives the calibration data packet and determines a calibration value for the second node to optimize the transfer of data from the first node to the second node.

A method for self calibrating a network in accordance with another aspect of the present invention comprises transmitting a calibration data packet from a first node. The calibration data packet is received by a second node and used in determining a calibration value for the second node to optimize the transfer of data from the first node to the second node.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the present invention will become apparent to those skilled in the art from the following description with reference to the drawings, in which:

Fig. **1** shows a self-learning and self-adjusting home network transceiver, in accordance with the principles of the present invention.

Fig. **2** shows a self-learning and self-adjusting network of home network transceivers, in accordance with the principles of the present invention.

Fig. **3** is a flow chart illustrating an exemplary process of channel learning and optimizing a home network, in accordance with the principles of the present invention.

Fig. **4** shows a conventional star network.

Fig. **5** shows a conventional ring network.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The present invention provides a method and apparatus for adjusting the properties of a home network transceiver device based on the particular needs of a given installation to optimize data bandwidth. In accordance with the principles of the present invention, a transceiver optimizes its transmissions with other transceivers through a training signal and procedure.

Fig. **1** shows a first embodiment in accordance with the principles of the present invention. Fig. **1** shows a home network transceiver that is self-learning and self-adjusting to optimize its communication performance with other home network transceivers.

In particular, Fig. **1** shows a home network transceiver **10** comprising a transceiver **75**, a noise measurement module **65**, a propagation delay measurement module **55**, a bit rate error measurement module **45**, a read station ID module **35**, a processor **25**, an ID and calibration memory **15**, and a test signal generator module **85**.

In operation, test signal generator module **85** initially generates a pre-established default test signal. The pre-established default test signal is transferred to transceiver **75**. Transceiver **75** transmits the pre-established default test signal to a second home network transceiver over communication link **76**.

The second home network transceiver returns the pre-established default test signal to home network transceiver **10** over communication link **77**. Transceiver **75** communicates the pre-established default test signal to each of the noise measurement module **65**, the propagation delay measurement module **55**, the bit rate error measurement module **45**, and the read station ID module **35**.

Noise measurement module **65** analyzes the pre-established default test signal returned from the second home network transceiver and communicates a noise measurement value to processor **25**.

Propagation delay measurement module **55** analyzes the pre-established default test signal returned from the second home network transceiver and communicates a propagation delay value to processor **25**.

Bit rate error measurement module **45** analyzes the pre-established default test signal returned from the second home network transceiver and communicates a bit rate error value to processor **25**.

Read station ID module **35** analyzes the pre-established default test signal returned from the second home network transceiver and communicates a station ID value of the second home network tranceiver to processor **25**.

Processor **25** receives the noise measurement value, propagation delay value, bit rate error value, and a station ID value. Processor analyzes the the noise measurement value, propagation delay value, and bit rate error value respectively received from modules **45**, **55** and **65** and stores an initial calibration value associated with the received ID in ID and calibration memory **15**.

Processor **25**, after having analyzed the noise measurement value, propagation delay value, and bit rate error value, determines whether any of the values are outside of an acceptable range. If any of the values are outside of an optimized range, processor **25** instructs test signal generator module **85** to create a new test signal. The new test signal incrementally changes the transmission properties of home network transceiver **10** to try and improve communication properties between home network transceiver **10** and a second home network transceiver.

The new test signal is transmitted from home network transceiver **10** to a second home network transceiver, as described above for the pre-established default test signal. The new test signal is transmitted back to the home network transceiver **10**, where the new test signal is analyzed to again determine the communication characteristics

between home network transceiver 10 and a second home network transceiver.

Processor **25** compares the noise measurement value, propagation delay value, and bit rate error value respectively returned from modules **45**, **55** and **65** relative to the new test signal with the values initially stored from analysis of the pre-established default test signal. If any of the values produced by modules **45**, **55** and **65** indicate a loss in communication quality between the home network transceiver **10** and a second home network transceiver, processor 25 does not store the configuration producing a loss of quality for that particular ID.

If processor **25** compares the values returned from modules **45**, **55** and **65** relative to the new test signal with the values initially stored from analysis of the pre-established default test signal and determines a greater reliability in communication between home network transceiver **10** and a second home network transceiver, a new calibration value is stored in ID and calibration memory **15** associated with a second home network transceiver having that particular ID.

Processor **25** analyzes test signals generated by test signal generator **85** and incrementally changes the signal generated by the test signal generator **85**. All possible combinations of testing parameters are used to create numerous test signals that assure that the signal quality received by transceiver **75** from a second home network transceiver is of the highest quality available based on such transmission characteristics as noise, propagation delay, and bit rate, the process ends for that particular ID.

The processor **25** initiates the calibration procedure for all the home network transceivers connected to the home network. Once all the home network transceivers within the home network have been calibrated, each has the ability to communicate with one another with optimized individualized calibration values for their respective

transceivers, thus optimizing communication for any particular environment the home network transceiver is used in.

Although the exemplary embodiment shown in Fig. **1** discloses individual modules performing the functions of home network transceiver **10**, the functions may be consolidated into fewer modules without affecting the function of the invention.

Although the exemplary embodiment shown in Fig. **1** discloses individual modules performing the functions of home network transceiver **10**, many of the functions may be performed through software executed by processor 25 without affecting the function of the invention.

Although the exemplary embodiment shown in Fig. **1** discloses a home network transceiver 10 utilizing a transceiver 75 having two communication paths 76 and 77, the invention is applicable to home network transceivers using any type of transceiver, e.g., wireless transceiver, fiber optic transceiver, co-axial transceiver, phone line transceiver, etc.

Fig. **2** shows a second embodiment in accordance with the principles of the present invention. Fig. **2** shows a home network transceiver connected to other transceivers that is self-learning and self-adjusting to optimize its communication performance with the other transceivers.

In particular, Fig. **2** shows node **100** connected to two other nodes, node **120** and node **130**. Transmission line **135** connects node **100** with node **120** and node **130**. Transmission line **125** connects node **120** to node **100** and **130**. Communication lines **112** and **114** connects node **100** with processor **110**, for respectively sending and receiving data. A calibration memory 140 within node 100 stores calibration values associated with a particular node identification (ID).

Although the exemplary embodiment shown in Fig. **2** discloses the connection of three nodes, the actual number of nodes that

are connectable within the network is limited only by the hardware used to connect the nodes and the number of actual nodes. In addition, although processor **110** shown in Fig. **2** is external to node **100** within the network, the processor can be incorporated within node **100** without affecting the function of the invention.

In operation, node **100** communicates with either node **120** or node **130** over transmission line **130** and transmission line **125**. At any specific time, only one pair of stations communicate, one for transmitting and the other for receiving.

Beginning with either node **120** or node **130**, one of the two nodes transmits a test signal to node **100**. Exemplary, using node **130** as the first node to be calibrated with node **100**, a test signal is transmitted by node **130** to node **100**. Node **100** receives a node ID value indicating the origin of the communication signal and a test signal within the received calibration data packet.

Station **100** communicates the test signal received within the calibration data packet from node **130** to processor **110** over communication line **112**. Processor **110** then analysis the properties of the test signal, e.g., noise within the signal, the propagation delay between the nodes, error rate within the bit pattern, etc. The analysis produces a calibration value that is communicated back to node **100** over communication line **114**.

The calibration value received by node **100** from processor **110** is stored in calibration memory **140**. This calibration value is used to adjust the transceiver's properties to optimize the transmission and reception of data to and from node **130**.

A test signal is sent by each of the remaining nodes **100** and **120** to the other within the network to likewise calibrate node **120** and node **130** within the network, as calibration of node **100** was described

above. In this manner, all the nodes within the network are calibrated for optimum performance with each other communicating node.

Although the preferred embodiment describes optimizing each node within the network for optimum performance with each other node within the network, one calibration value can be used within a particular node for communication with multiple nodes. The use of one calibration value is a compromise for most of the nodes within the network, however, one calibration value simplifies communication within the network by not having to switch between calibration values based on the particular node being communicated with at any given time.

Fig. **3** shows a method for calibrating a node's operation within respect to other nodes within a network for optimum performance.

Fig. **3** describes node **130** transmitting its node ID and calibration data packet to node **100**, as shown in Fig. **2**. The method described in Fig. **3** in relation to node **100** and node **130** is exemplary for the transmission and reception of a calibration data packet used for calibration of all the nodes within the network of Fig. **2**.

In step **200**, a calibration data packet is transmitted by node **130** while no other nodes are transmitting data on the network.

To prevent other nodes on the network from transmitting during the calibration process, a network lock is issued by the node initiating the calibration data packet. The network lock prevents other nodes from trying to gain access to the network until a subsequent network unlock signal is issued by the transmitting node. This prevents other nodes on the network from possibly interfering with and/or effecting the calibration results experienced by the receiving node.

In step **210**, node **100** from Fig. **2** receives the calibration data packet transmitted by node **130** in step **200**.

In Step **220** the node ID within the calibration data packet is read by node **100**, and the calibration data packet is transferred to processor **110**.

In step **230,** the calibration data packet is analyzed to determine what the optimal calibration value to be associated with the node ID of the transmitting node should be.

In step **240**, a decision is made if the is still room to improve the performance of the communication link between node **100** and node **130**.

If there is room to improve the performance of the communication link between node **100** and node **130**, the method branches to step **260**. Step **260** calculates new receiving parameters for the transceiver, which are written to the transceiver **100** at step **270**. The method then branches from step **270** to step **210** to again receive a calibration data packet. Once the calibration data packet is again received, the process for determining the optimal parameters is repeated until the optimal parameters are determined.

If the calibration data packet analyzed in step **230** is determined to be optimal with no further changes to the transceiver at node **100** needed, the method branches to step **280**.

Step **280** determines if other nodes need to be calibrated for transceiving data with node **100**. If other nodes do need to be calibrated for communication with node **100**, the program branches to step **290**. In step **290**, a signal is transmitted over the network to node **130** indicating that the calibration process for that node has been completed. In addition, step **290** also issues a network unlock signal. The network unlock signal allows other nodes on the network to begin their calibration process.

If a determination is made at step **280** that all the nodes within the network, based on node IDs, have been calibrated, the

subroutine branches to step **300**. Step **300** ends the calibration subroutine.

Although the present invention is described with reference to embodiments of calibrating a home or small business LAN using transmission lines, the principles of the present invention are equally applicable to calibrating a LAN using wireless transceivers.

Although the present invention is described with reference to embodiments of calibrating each node within a network for a home or a small business, the principles of the present invention are equally applicable to determining a calibration value between any two nodes within a network and transmitting the calibration value to the other nodes within the network.

Moreover, while the disclosed embodiments relate to HomePNA systems, the principles have equal applicability to Ethernet based systems and packet based applications in general.

While the invention has been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments of the invention without departing from the true spirit and scope of the invention.